electrolyte in the homogenous state cannot be obtained by using these mixtures.

Further, proposed are a copolymer of fluoroolefin with a hydrocarbon having an unsaturated bond (Japanese Laid-Open Patent Publication No. Hei 11-39941), and a copolymer in which acrylic acid is grafted with polyvinylidene fluoride by irradiation of γ-ray (U.S. Patent No. 6,037,080). However, these copolymers have a low affinity with liquid organic electrolytes and do not readily form a gel electrolyte.

Consequently, lithium polymer batteries having a gel electrolyte are generally inferior in the storage characteristics at high temperatures as compared with lithium ion batteries having no gel electrolyte. For example, when lithium polymer batteries are stored at 80 ℃ for three days, the capacity obtained by one hour rate discharging could be reduced to 80% or less of the capacity before the storage.

BRIEF SUMMARY OF THE INVENTION

The present invention has an object to render a gel electrolyte homogenous and excellent in the affinity with a liquid organic electrolyte by using a specific copolymer as a host polymer of the gel electrolyte constituting a separator, thereby to improve the stability at high temperatures of the gel electrolyte and to provide a highly reliable lithium polymer battery which is excellent in the storage characteristics at high temperatures.

Specifically, the present invention relates to a lithium polymer battery including: a positive electrode comprising a lithium-containing complex oxide; a negative electrode comprising a material capable of absorbing and desorbing a lithium ion; and a separator comprising a liquid organic electrolyte and a host polymer retaining the liquid organic electrolyte, wherein the host polymer is a crosslinked copolymer, which has a main-chain comprising a vinylidene fluoride unit, and a side-chain comprising an alkylene oxide unit and at least one of an acrylate unit and methacrylate unit.

In the aforementioned copolymer, the content of the side-chain is preferably 1 to 30 wt%.

The aforementioned side-chain is preferably composed of polyethylene glycol diacrylate or polyethylene glycol dimethacrylate wherein an average molecular weight of the diacrylate or dimethacrylate is 300 to 1600.

At least one of the positive electrode and the negative electrode preferably contains a binder comprising a modified polyvinylidene fluoride having an oxygen-containing group.

The positive electrode preferably contains a binder comprising a modified vinylidene fluoride-hexafluoropropylene copolymer having an oxygen-containing group.

The negative electrode preferably contains a binder comprising an ionomer containing at least one of an acrylate

unit and methacrylate unit.

The negative electrode preferably contains a binder comprising a particulate rubber containing an acrylonitrile unit, a styrene unit and a butadiene unit.

The present invention also relates to a method for producing a lithium polymer battery comprising:

(1) a step of preparing an electrode assembly by laminating a positive electrode and a negative electrode while interposing therebetween a copolymer having a main-chain comprising a vinylidene fluoride unit and a side-chain comprising an alkylene oxide unit and at least one of an acrylate unit and methacyrylate unit;

(2) a step of housing the aforementioned electrode assembly into a battery case, and subsequently introducing a thermal polymerization initiator for the copolymer and a liquid organic electrolyte therein and sealing the battery case; and

(3) a step of forming a separator comprising a gel electrolyte between the positive electrode and the negative electrode by heating the sealed battery to crosslink the copolymer and make the crosslinked copolymer retain the organic electrolyte.

By the above method, since the host polymer is crosslinked by thermal polymerization after the host polymer have contained the liquid organic electrolyte, a gel electrolyte which has a close and chemically stable network